Reaction Functions of the Participants in Colombia's Large-value Payment System

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Take away messages

- This subject is essential for central banks because it enables them to achieve the legal mandate of ensuring the normal functioning of payments.
- A Central Bank, which is provider/operator of a LVPS, could consider optimum promoting a more cooperative behaviour in the sending of payments.
- Entities' payments reaction functions vary per types of incidents and entities.

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Introduction

Large Value Payments Systems (LVPS):

- Settle the orders of payments between the entities that partake in the financial market.
- In this system can participate banks, brokerage firms, mutual funds, financial corporations, pensions fund managers, financial cooperatives, and insurance companies, amongst many others.

Introduction

- The Colombian LVPS is known as CUD.
- From 1998 until 2006 the CUD operated as a pure RTGS.
- In 2006 the Central Bank incorporated a queuing structure with two liquidity savings mechanisms:
  - The **netting cycles**, scheduled at 11:50, 14:20, 15:30, 16:15 and 17:45.
  - The **retrial mechanism** that is activated at 14:30 and re-started every 30 minutes.

Introduction

A **Netting cycle** is an automated mechanism that checks an entity's account balance, and calculates the offset value of incoming transfers and outgoing payments. If the funds in an entity's account are sufficient this value is settled.

The **retrial mechanism** consists of a periodic automatic action to see if there is enough balance in the entities' accounts in order to settle delayed payment orders.

Introduction

An entity can fund its payments using (McAndrews and Potter, 2002):

- Its own deposits at the central bank.
- Loans from the central bank.
- Money market loans.
- Incoming transfers from other participants of the system.

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Literature Review

- McAndrews and Potter (2002).
- Bech and Garrat (2003).
- Bech and Garrat (2012).
- Bernal, Cepeda and Ortega (2012).
- Ledrut (2007), Mills and Nesmith (2008), Merrouche and Schanz (2010), and Perlin and Schanz (2010).

Literature Review

As stated in Bedford, et al. (2005), payments flow can be disrupted by :

1. Failures that affect the system operator.
2. Failures in the communication networks.
3. Failures caused by the inability of one participant to submit payment instructions to the system.

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The estimation methodology

A payment reaction function (PRF) is defined by McAndrews and Potter (2002) as a linear relationship between the payments sent (P_t^A) and received (R_t^A) by an entity:

$$P_t^A = \alpha + \beta R_t^A + \varepsilon_t \qquad (1)$$

α: autonomous willingness to send payments.
β: marginal propensity to send payments.
ε_t: error term.

The estimation methodology

The dependent variable is the total value of payments that entity A sent per minute (P_t^A):

$$P_t^A = \begin{cases} P_t^{A*} & if \quad P_t^{A*} > 0 \\ 0 & otherwise \end{cases}$$

The Tobit model with random effects is suitable for this data:

$$P_t^{A*} = \alpha + X_t^{A\prime}\beta + \varepsilon_t \qquad (2)$$

$$\varepsilon_t / X_t^{A\prime} \sim Normal(0, \sigma^2) \qquad (3)$$

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Data

- P_t^A: total amount of payments sent by an entity.
- Set of regressors:
  - Total payments received from other entities via CUD in the previous 15 minutes.
  - Opening balance.
  - Cumulative receipts minus its cumulative payments sent up 16 minutes prior to the minute.
  - Dummy for netting cycles.
  - Dummy for automatic payments CEDEC & CENIT.

Data

We examined each incident in a separate way.

Hence, we used specific '*benchmarks*' per incident:

Incident	**Date**	***Benchmark***
The Blackout	April 26, 2007	April 1- 25, 2007
Bancolombia's operational failure	Feb 26-28, 2010	Feb. 1- 25, 2010
Failure of Proyectar Valores	June 23, 2011	June 1- 22, 2011
Failure of Interbolsa	Nov. 2, 2012	Oct.1- Nov.1, 2012

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The Blackout

	Benchmark (April 1st-25th)			
	All	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.025	0.023	0.008	0.101
	(3.11)***	(3.85)***	(0.76)	(10.08)***
Autonomous willingness to send payments	1.9E+09	2.2E+09	1.5E+09	2.5E+09
	(8.90)***	(6.77)***	(4.85)***	(4.12)***
Number of observations	39,444	19,875	15,627	3,942
Number of participants	25	8	7	10

	The Blackout (April 26th)				April 27th				April 30th				May 2nd			
	All	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.024	0.025	0.0003	0.120	0.018	0.002	0.013	0.131	0.028	0.019	0.042	0.065	0.022	0.019	0.021	0.080
	(1.47)	(1.19)	(0.02)	(4.05)***	(0.69)	(0.11)	(0.44)	(2.38)***	(1.66)*	(0.84)	(0.99)	(0.40)	(4.09)***	(1.72)*	(1.45)	(0.70)
Autonomous willingness to send payments	1.9E+09	2.8E+09	1.7E+09	1.3E+09	1.8E+09	3.2E+09	1.8E+09	2.0E+09	2.0E+09	2.4E+09	2.8E+09	2.2E+09	1.9E+09	2.5E+09	2.8E+09	2.5E+09
	(4.31)***	(1.59)	(1.37)	(2.28)**	(5.59)***	(1.71)*	(2.54)***	(4.44)***	(6.25)***	(1.88)*	(2.62)***	(1.78)*	(8.43)***	(3.38)***	(0.76)	(3.43)***
Number of observations	2,486	1,275	950	261	2,582	1,370	958	254	2,484	1,384	801	299	2,779	1,429	1,066	284
Number of participants	25	8	7	10	24	8	7	9	25	8	7	10	25	8	7	10

Bancolombia's operational failure

	Benchmark (February 1st-25th)			
	All	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.009	0.007	0.008	0.085
	(1.84)*	(1.44)	(1.02)	(5.63)***
Autonomous willingness to send payments	2.5E+09	4.6E+09	-1.3E+08	-1.5E+09
	(2.59)***	(3.18)***	(-0.26)	(-4.86)***
Number of observations	60,563	27,229	25,615	7,719
Number of participants	26	8	8	10

	Bancolombia's operational failure (February 26th)				March 1st				March 2nd				March 3th			
	All	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.008	0.002	-0.005	0.057	0.000	-0.007	0.011	0.070	0.035	0.028	0.023	0.020	0.002	-0.003	0.002	0.031
	(1.33)	(0.14)	(-0.26)	(8.18)***	(-0.02)	(-0.62)	(1.08)	(2.66)***	(2.17)**	(1.52)	(1.04)	(1.12)	(0.32)	(-0.33)	(0.09)	(1.34)
Autonomous willingness to send payments	2.5E+09	4.6E+09	-1.3E+08	-1.5E+09	2.1E+09	2.3E+09	7.6E+07	-5.2E+09	8.5E+08	2.2E+09	-1.4E+09	1.7E+09	1.8E+09	3.9E+09	2.0E+09	2.7E+09
	(2.59)***	(3.18)***	(-0.26)	(-4.86)***	(0.78)	(0.99)	(0.04)	(-6.57)***	(0.60)	(1.22)	(-2.34)***	(1.57)	(3.71)***	(2.65)***	(1.15)	(4.36)***
Number of observations	2,821	1,397	1,084	340	3,334	1,551	1,342	441	2,895	1,327	1,162	406	3,041	1,348	1,307	386
Number of participants	26	8	8	10	26	8	8	10	26	8	8	10	26	8	8	10

The Failure of Proyectar Valores

	Benchmark (June 1st-22th)			
	All	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.029	0.031	0.003	0.094
	(3.90)***	(4.41)***	(0.45)	(4.72)***
Autonomous willingness to send payments	1.9E+09	2.2E+09	2.5E+09	3.3E+09
	(3.80)***	(5.25)***	(8.36)***	(4.11)***
Number of observations	43,466	20,081	18,268	5,117
Number of participants	26	8	8	10

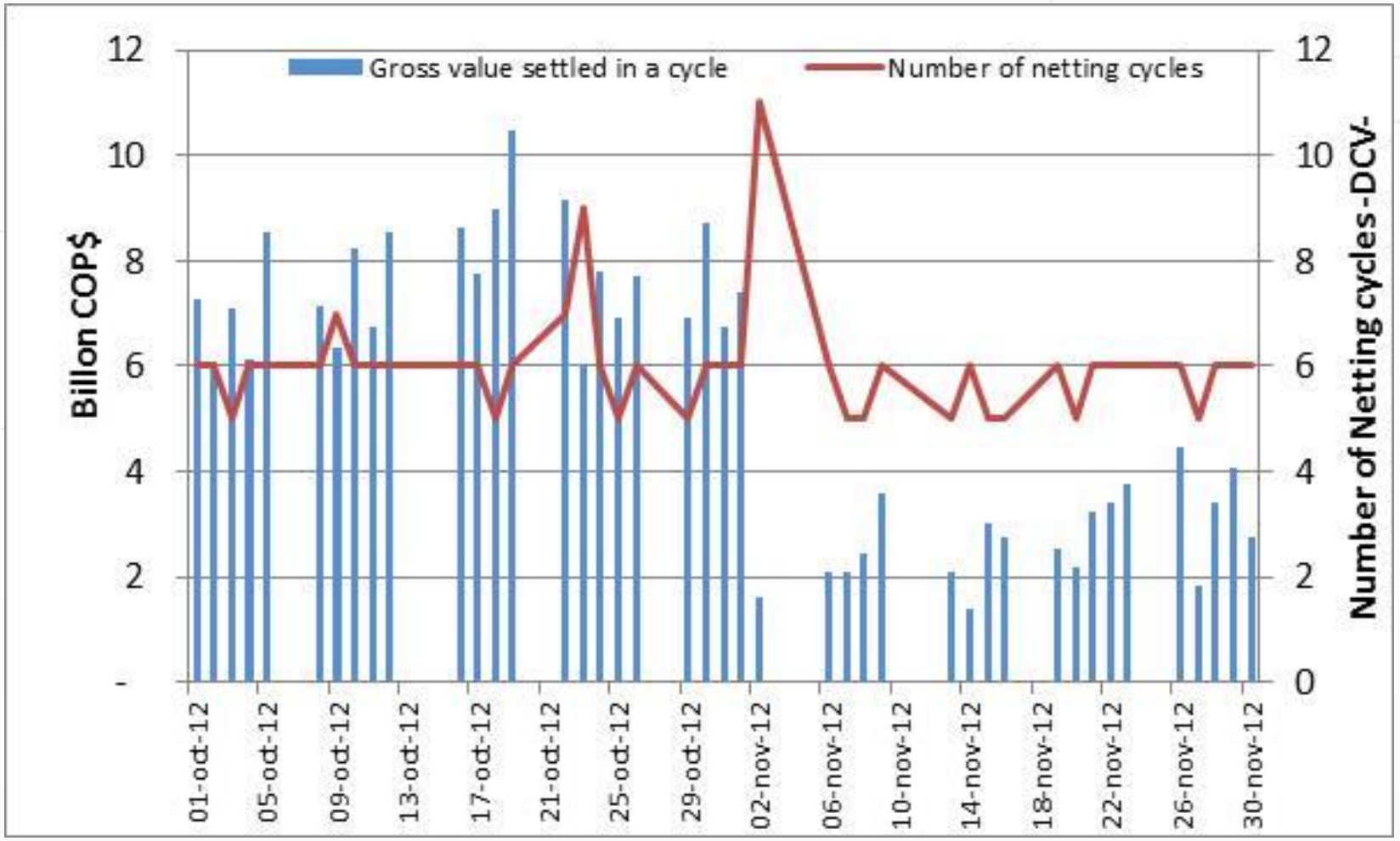
	Proyectar Failure (June 23th)				June 24th				June 28th				June 29th			
	All	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.026	0.022	0.019	0.092	0.012	0.011	0.007	0.058	0.010	0.006	0.034	0.118	0.028	0.028	0.016	0.113
	(1.08)	(0.89)	(1.77)*	(5.23)***	(1.30)	(0.78)	(0.42)	(2.50)***	(1.30)	(0.75)	(1.77)*	(5.20)***	(3.52)***	(4.52)***	(1.09)	(2.24)**
Autonomous willingness to send payments	1.9E+09	2.2E+09	2.5E+09	3.3E+09	3.3E+09	4.5E+09	1.1E+09	2.4E+09	2.0E+09	4.0E+09	1.7E+09	2.5E+09	1.6E+09	4.9E+08	6.6E+08	1.7E+09
	(3.80)***	(5.25)***	(8.36)***	(4.11)***	(2.07)**	(0.87)	(0.74)	(3.88)***	(4.58)***	(3.62)***	(1.77)*	(6.27)***	(3.26)***	(0.21)	(0.51)	(2.59)***
Number of observations	3,013	1,329	1,292	392	2,873	1,323	1,203	347	2,809	1,349	1,142	318	26,834	25,394	1,087	353
Number of participants	26	8	8	10	26	8	8	10	26	8	8	10	26	8	8	10

The Failure of Interbolsa

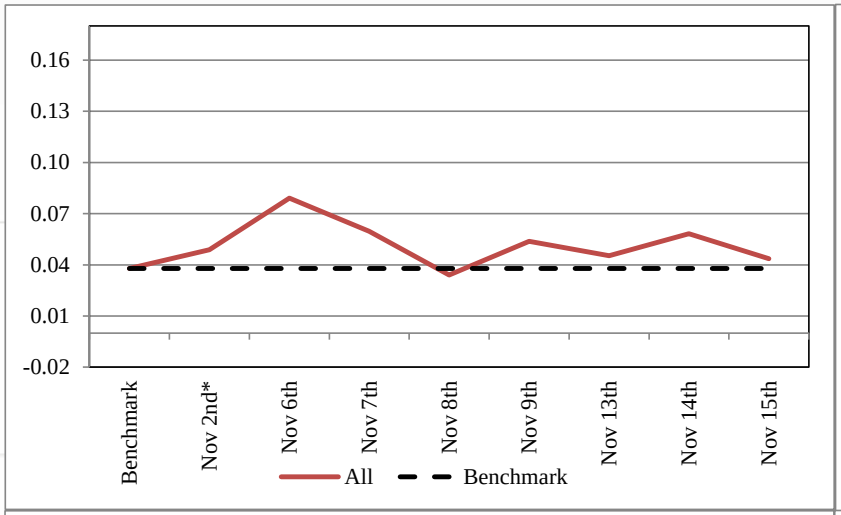
	Benchmark (October 1st to November 1st)			
	All	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.038	0.044	0.004	0.089
	(2.25)**	(2.12)**	(0.71)	(7.33)***
Autonomous willingness to send payments	1.5E+09	1.8E+09	2.2E+09	2.8E+09
	(2.93)***	(2.12)**	(6.20)***	(7.39)***
Number of observations	66,245	31,248	26,835	8,162
Number of participants	26	8	8	10

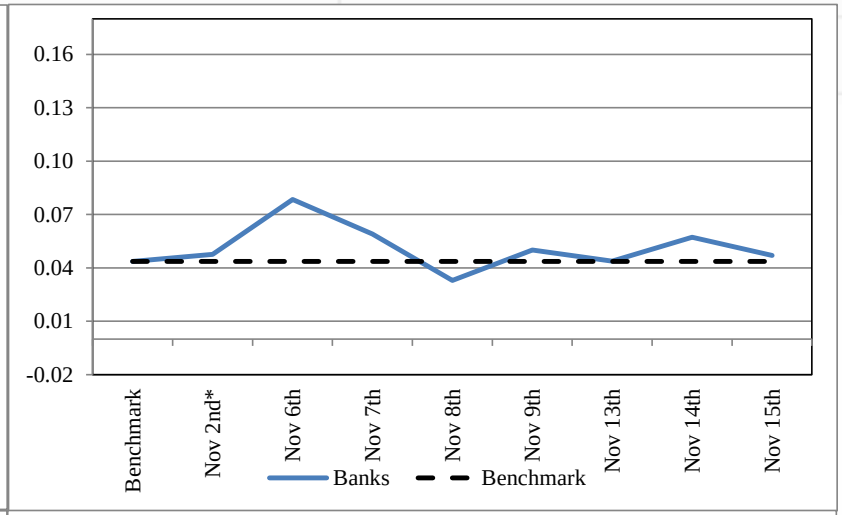
	Interbolsa collapse (November 2nd)				November 6th				November 7th				November 8th			
	All	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*	*All*	*Banks*	*Brokerage firms*	*Mutual funds*
Reaction function slope	0.049	0.048	0.036	0.161	0.079	0.078	0.073	0.172	0.060	0.059	0.064	0.127	0.034	0.033	0.043	0.054
	(1.96)**	(1.36)	(1.35)	(7.94)***	(4.24)***	(1.82)*	(6.11)***	(4.04)***	(3.69)***	(1.51)	(4.15)***	(4.08)***	(6.21)***	(2.25)**	(9.60)***	(2.64)***
Autonomous willingness to send payments	1.5E+09	1.8E+09	2.2E+09	2.8E+09	2.7E+09	6.2E+09	2.7E+09	2.3E+09	2.7E+09	4.5E+09	2.6E+09	1.9E+09	2.6E+09	4.0E+09	1.8E+09	2.2E+09
	(2.93)***	(2.12)**	(6.20)***	(7.39)***	(5.61)***	(4.01)***	(4.72)***	(3.64)***	(5.43)***	(2.50)***	(4.86)***	(1.84)*	(5.04)***	(1.91)*	(2.13)**	(3.79)***
Number of observations	2,591	1,287	978	326	2,144	1,216	668	260	2,469	1,314	831	324	2,434	1,333	760	341
Number of participants	26	8	8	10	26	8	8	10	26	8	8	10	26	8	8	10

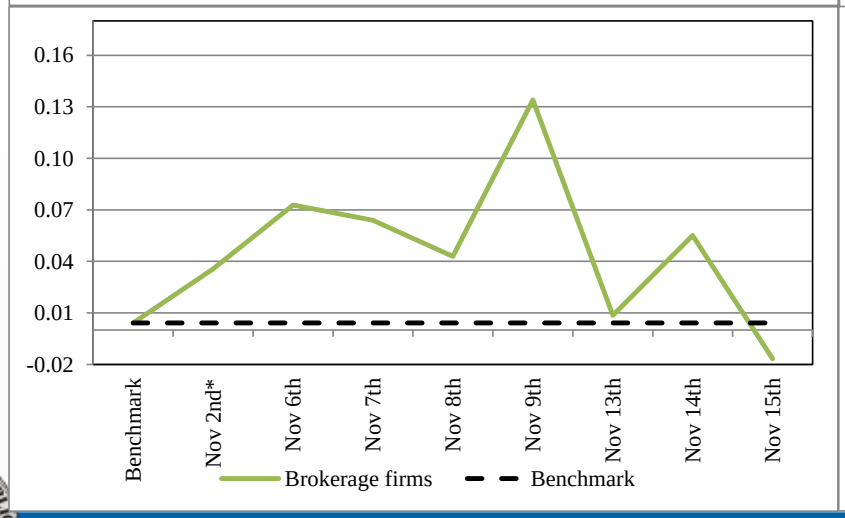
The Failure of Interbolsa

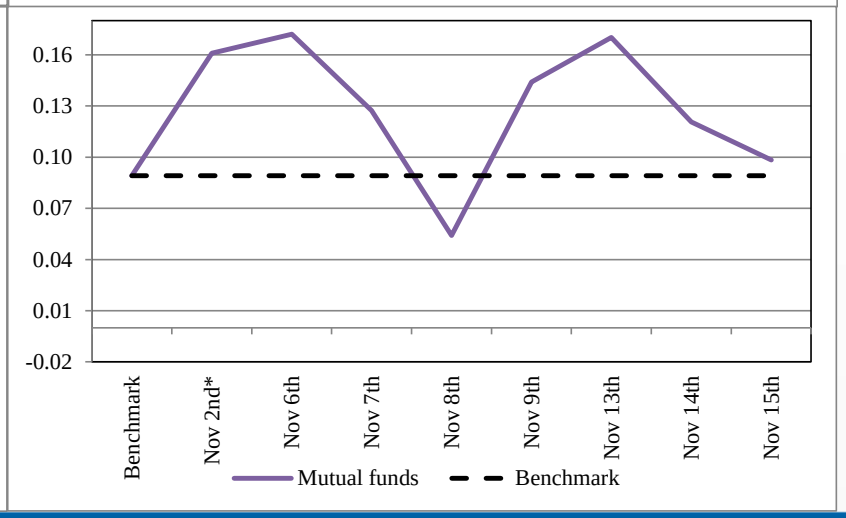


The Failure of Interbolsa: Estimated slope of PRF per type of entity









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Conclusions

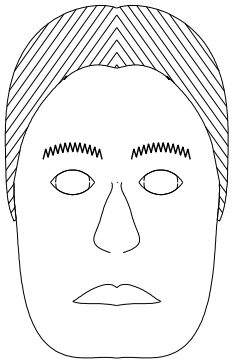
- The PRF measures how the strategy of sending payments could be affected by disruptions.
- In general, there is coordination in the sending of payments.
- An entity's reaction depends on the type of incident, type of entity and its role in the market.
- After the failure of Interbolsa, the system's resilience took around seven working days.

The failure of Interbolsa: Chernoff faces

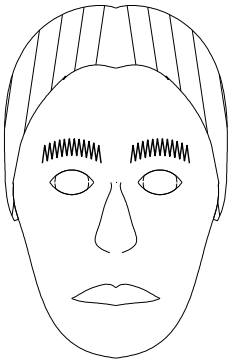
- Estimated slope of PRF (mouth curvature)
- Value of payments (hair darkness and shading slant)
- Opening balance (pupil size)
- Central bank liquidity (nose)
- Percentage in the num. of payments sent (face line)
- *Hub centrality* (eyebrows density).

THE BENCHMARK

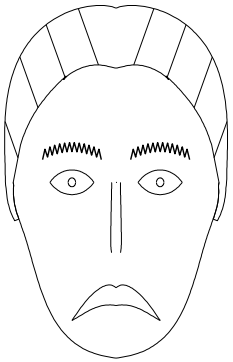
All



Banks



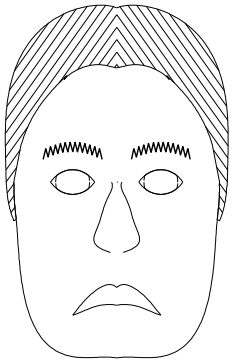
Brokerages



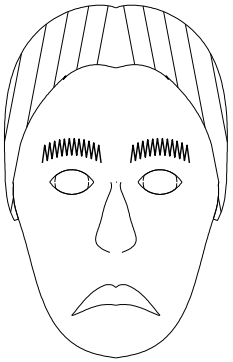
Mutual_funds

THE FAILURE

All



Banks



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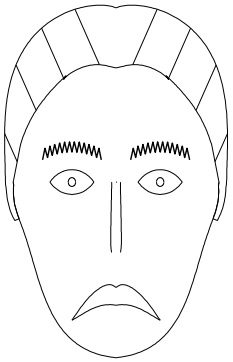
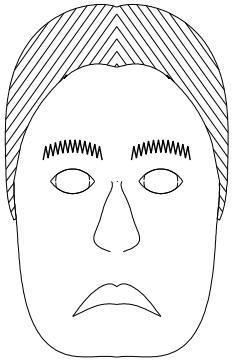


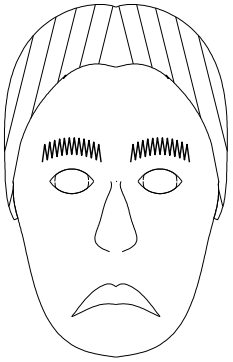
Mutual funds

ONE DAY LATER

All



Banks



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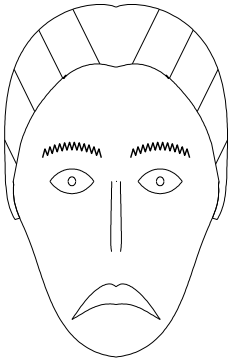
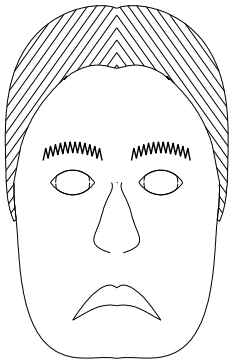


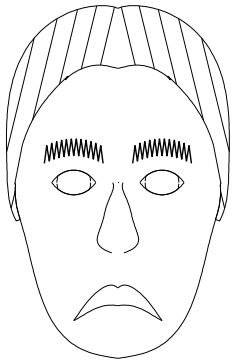
Mutual funds

TWO DAYS LATER

All



Banks



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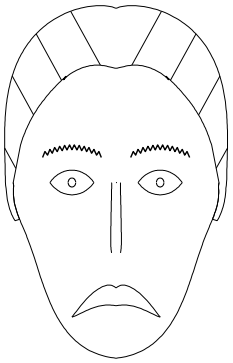
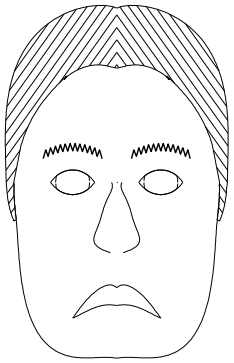


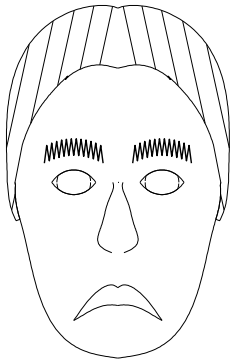
Mutual funds

THREE DAYS LATER

All



Banks



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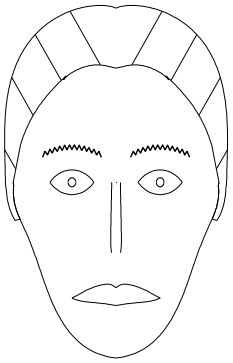
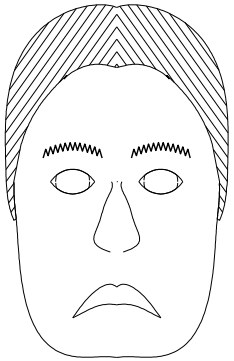


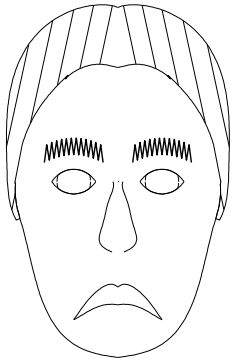
Mutual funds

FOUR DAYS LATER

All



Banks



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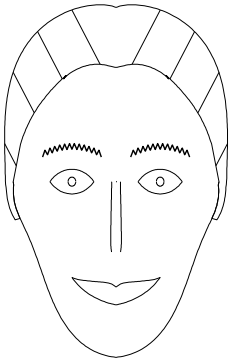
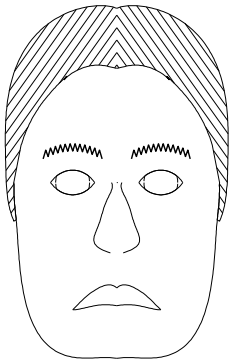


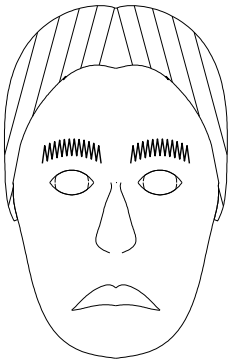
Mutual funds

FIVE DAYS LATER

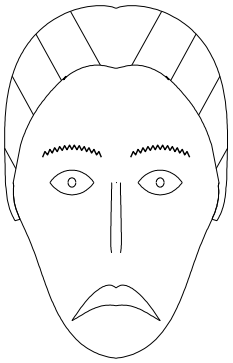
All



Banks



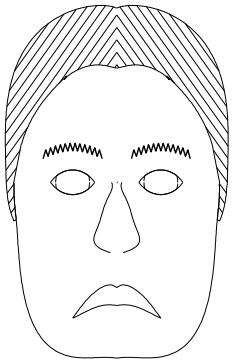
Brokerages



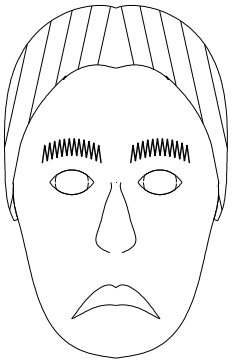
Mutual funds

SIX DAYS LATER

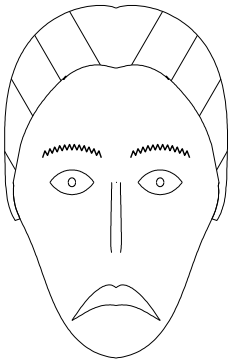
All



Banks



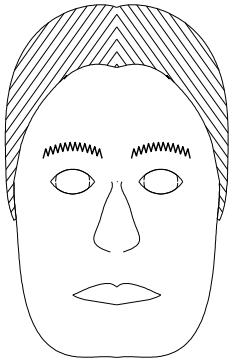
Brokerages



Mutual funds

SEVEN DAYS LATER

All



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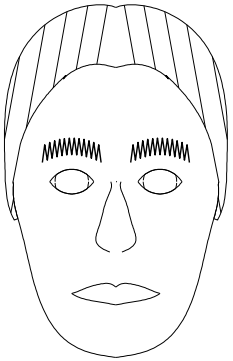

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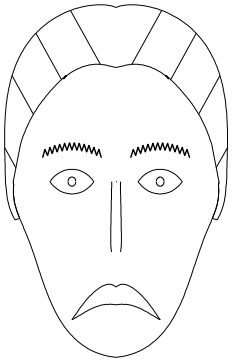

Mutual funds

A measure of policy to consider…

The implementation and enforcement of specific policies that force entities to send payments early, such as the binding throughput rules that were successfully adopted in CHAPS (U.K).

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Possible extensions

- Develop a methodology that characterises specific system participants' behaviour.
- Identify undesirable behaviours (*free-rider*).
- Analyse the relationship between PRF and the spread of central bank's liquidity (*Super-spreaders*).

Reaction Functions of the Participants in Colombia's Large-value Payment System

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